SHORT COMMUNICATION

The glucose metabolism disorder and dyslipidemia among girls with different phenotype polycystic ovary syndrome

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Background: This study aimed to determine the prevalence of glucose metabolism disorder and dyslipidemia in 14–18-year-old girls with different phenotype polycystic ovary syndrome (PCOS). **Materials and Methods:** This descriptive, cross-sectional study was conducted on 3200 high-school adolescents aged 14–18 years in Shiraz in 2010. Selected parameters of metabolic syndrome (fasting blood glucose, glucose tolerance test [GTT], insulin level, triglyceride (TG), cholesterol, and high-density lipoprotein [HDL]), based on adult treatment panel III definition criteria, were compared between the "PCOS" and control groups. **Results:** Results were compared at four main phenotypes. The level of serum TG was increased in the Phenotype B ($P = 0.03$) and Phenotype D ($P = 0.01$), compared to the control group. Cholesterol and low-density lipoprotein levels ($P < 0.05$) and GTT ($P > 0.05$) were increased, and HDL was decreased (was below 50) in all the four phenotypes and the control group ($P > 0.05$). **Conclusion:** The risk of metabolic alterations of glucose metabolism disorder and dyslipidemia in PCOS adolescents was more than non-PCOS counterparts.

Key words: Metabolic syndrome, phenotype, polycystic ovarian syndrome

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INTRODUCTION

Polycystic ovarian syndrome (PCOS) is multifactorial with a genetic component and the most prevalent endocrine disorder among women of reproductive ages. Women's "diagnostic criteria" for PCOS in various age groups (15–45 years) were 9%–18%.[1,2]

A previous study indicated that PCOS affected the metabolism of carbohydrates, lipids, and amino acids. In addition, lactate, long-chain fatty acids, triglycerides (TGs), and low-density lipoprotein (LDL) levels increased, while glucose, phosphatidylcholine, and high-density lipoprotein (HDL) concentrations decreased in the patients with PCOS compared to the control group.[3] Besides, different phenotypes of PCOS include (a) hyperandrogenism and PCOS and oligomenorrhea, (b) hyperandrogenism and oligomenorrhea, (c) hyperandrogenism and PCOS, and (d) PCOS and oligomenorrhea.[3,4]

Although a large number of studies have been conducted on the prevalence and parameters of this syndrome and its relationship with cardiovascular diseases among adults,[5,6] no exact definition is available for this syndrome in childhood and adolescence.[7] Based on the third National Health and Nutrition Examination Survey, a previous study reported the prevalence of metabolic syndrome (MS) to be 8.6% among adolescents.[8] In another study on the adolescents suffering from PCOS, the prevalence of MS was 18.8%, and it was related to body fat; also,

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the range of prevalence of lipid accumulation product was 8.6%–18.8%.[8]

Considering the increasing prevalence of MS among adolescents in developed counties, Asian countries,[9] and Iran,[10] paying attention to prevention and treatment of this disorder is of great importance in promotion of health. In this way, interventional programs can be developed and effective measures can be taken to prevent and treat the components of MS. The aim of study was determination of the prevalence of glucose metabolism disorder and dyslipidemia among girls with PCOS.

MATERIALS AND METHODS

Research design and study population

This study was approved by the ethics committee of Shiraz University of Medical Sciences**.** The target sample size was 3200 girls aged 14–18 years based on the previous studies conducted on the issue 18 and the following formula $n = \frac{z^2 p(1-p)}{d^2}$ and considering the loss rate of 20%. Of the 41 public high schools in four districts of Shiraz, 16 were selected and 3–4 schools were considered randomly as clusters. In a school, the students were selected based on purposive sampling [Figure 1].

The inclusion criteria of the study were the age range of 14–18 years and not having consumed any medications for at least 3 months before the study. The exclusion criteria of the study were passage of <2 years from the onset of menarche and not having adrenal, thyroid, hyperprolactinemia, and amenorrhea disorders. Then, the girls with clinical hyperandrogenism (acne, hirsutism, and alopecia) and oligomenorrhea underwent ultrasound and biochemical tests. Ultrasound was based on the criteria proposed by Adams *et al*. According to Akbarzada *et al*., the most important of them are existence of 10 small peripheral follicles.[11] It should be noted that the ultrasound specialist was unaware of the results of the patients' clinical examinations and biochemical tests.

Oral glucose tolerance test (OGTT) was done by a standard 75 g oral glucose given to the individual after

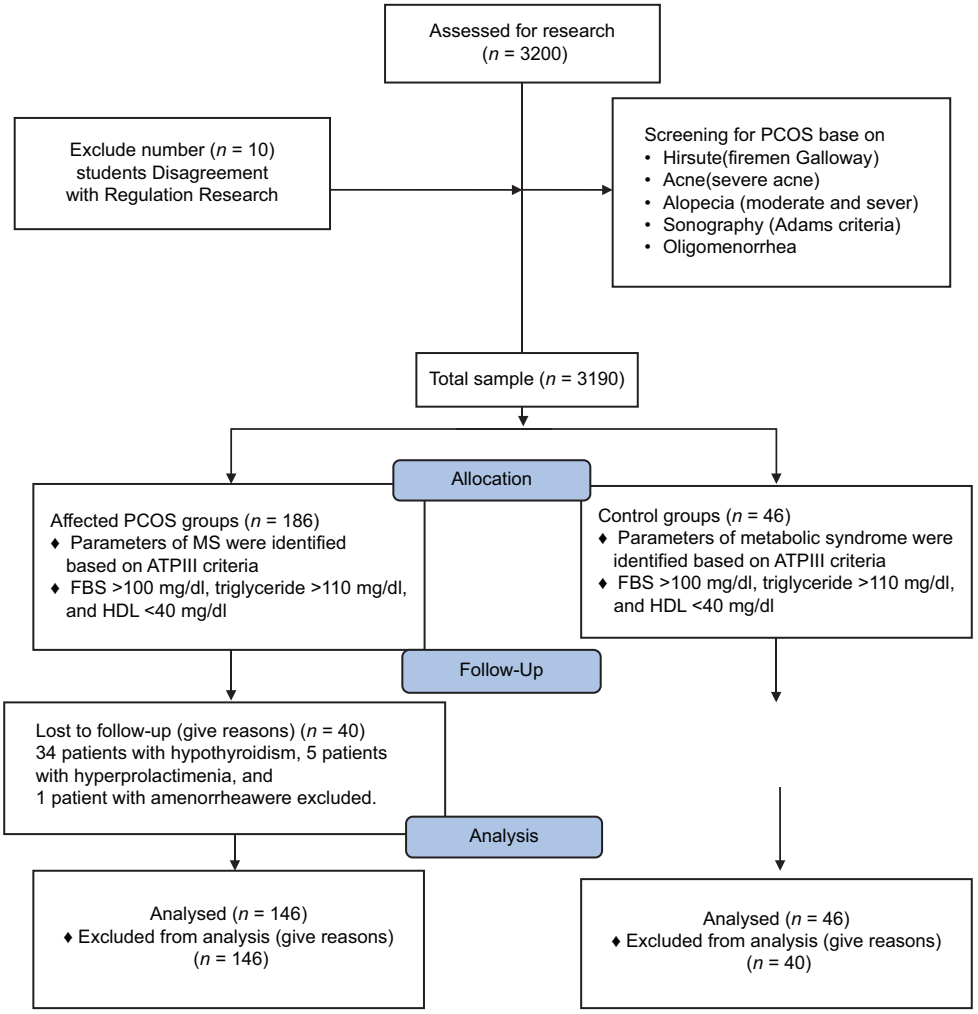

Figure 1: Flow diagram for sampling

10–12 h overnight fasting. Venous blood sample was taken 2 h after glucose load for fasting (FBS). Blood glucose levels were evaluated based on the criteria proposed by World Health Organization. Accordingly, blood glucose levels >140 mg/dl or <200 mg/dl were considered as glucose tolerance disorder.[12] Lipid profile including serum TG and cholesterol (Ch) and HDL was determined by commercial enzymatic methods; the kit used was Biomerieux Ltd., France. In addition, LDL-cholesterol was evaluated using Friedewald formula as follows: LDL = Chol-TG/5 + HDL.

In the second stage, based on clinical hyperandrogenism (acne, hirsutism, and alopecia), oligomenorrhea, ultrasound, and biochemical tests, 146 participants were diagnosed with PCOS by the specialist consultant (endocrinologist).

In the third stage, all the girls with PCOS (146 participants) were entered into the case group, while 46 participants with no symptoms were considered as the control group. In this study, the parameters of MS were identified based on adult treatment panel III criteria, i.e., waist circumference >90th percentile based on age/sex,[13] FBS >100 mg/dl, TG >110 mg/dl, and HDL <40 mg/dl.[14]

In this study, PCOS was diagnosed according to Rotterdam criteria. Based on the definition proposed by the society of reproduction and embryology in Europe and America's fertility committee in Rotterdam conference in 2003, 2 of the 3 following criteria are used as the diagnostic criteria of PCOS: (1) oligoovulation or anovulation, (2) clinical symptoms of hyperandrogenism or hyperandrogenemia, and (3) existence of polycystic ovary in sonography with exclusion of other endocrine disorders.[15]

Data analysis

The study data were analyzed through SPSS statistical software (version 16; SPSS Inc., Chicago, IL, USA), using *t*-test. All the tests were performed with confidence interval of 95% and $P \leq 0.05$.

Ethical considerations

This article was extracted from the research proposal approved by Student Research Committee of Shiraz University of Medical Sciences (proposal No. 6020), and all the authors approved this study.

RESULTS

The participants' mean age in the case and control groups was 16.17 ± 1.25 and 16.01 ± 1.1 years, respectively. The results showed a significant difference between the control group and the four phenotypes of the case group regarding the weight and body mass index ($P < 0.001$). The results indicated a significant difference between Phenotype B and the control group ($P = 0.03$) as well as between Phenotype D and the control group ($P = 0.018$) concerning serum TG level. Nonetheless, HDL was below 40 in both groups, and no significant difference was observed among the four phenotypes in this regard ($P > 0.05$). On the other hand, all the four phenotypes of PCOS were different from the control group with regard to cholesterol and LDL levels ($P < 0.05$) [Table 1].

FBS was below 100 in both study groups, and no significant difference in this regard was observed between the control group and all the phenotypes of PCOS ($P > 0.05$), except for clinical hyperandrogenism and oligomenorrhea ($P = 0.04$).

The mean of glucose tolerance test (GTT) was higher in the four phenotypes of PCOS compared to the control group; however, the results of *t*-test showed that this difference was not statistically significant ($P > 0.05$) [Table 2].

DISCUSSION

The results of the present study showed that TGs and blood lipid levels (cholesterol and LDL) were higher in the case group, while HDL level was lower in the entire population under the study. In addition, the most prevalent metabolic disorder was lower HDL and higher LDL in all the four phenotypes. However, Braga-Tavares and Fonseca reported that android obesity was the most (98.7% and 89.5%) and increase in blood glucose level was the least (2.5% and 1.3%) prevalent disorder.[16]

The results of our study showed that increased levels of TG and cholesterol and decreased HDL levels in the PCOS with phenotype B were higher.

In another study in Iran, worse metabolic results were reported in the phenotypes associated with the presence of hyperandrogenism (Type A, B, C); the results were similar to those of our study.[17] Furthermore, a significant relationship was found between these risk factors and coronary artery lesions and atherosclerosis in deaths resulting from cardiovascular disorders.[18,19] In a cohort study with a 25-year follow-up, the prevalence of cardiovascular diseases was 19.4% among the adults who had the clinical features of MS in childhood compared to 1.5% among those who lacked these features.[20]

Based on the findings of the present study, the mean of GTT was higher in different phenotypes of PCOS compared to the control group. Nonetheless, no cases with diabetes mellitus were found in the study groups, and all the participants had normal FBS levels. Yet, the mean of FBS was higher in PCOS Type A and Type D phenotypes compared to the control group. Recent studies have shown that fasting plasma

Table 1: The mean of the type of lipid in different phenotypes of polycystic ovarian syndrome

Phenotype	Mean±SD			
	Type A* Case: (*n*=79) Control: (*n*=46)	Type B** Case: (*n*=33) Control: (*n*=46)	Type C*** Case: (*n*=45) Control: (*n*=46)	Type D**** Case: (*n*=46) Control: (*n*=46)
Groups				
HDL				
Case	31.43±6.77	29.93±6.52	31.300±6.42	31.56±6.59
Control	32.58±0.74	32.58±0.74	32.58±0.74	32.58±0.74
P	0.482	0.193	0.459	0.56
LDL				
Case	123.71±26.50	129.23±30.61	130.046±26.27	127.76±28.07
Control	108.98±24.33	108.98±24.33	108.98±24.33	108.98±24.33
P	0.003	0.002	0.000	0.001
TG				
Case	123.66±61.15	136.67±79.76	116.60±45.34	128.95±47.05
Control	107.36±36.10	107.36±36.10	107.36±36.10	107.36±36.10
P	0.068	0.03	0.288	0.018
Ch				
Case	179.88±29.15	186.50±33.42	184.67±30.607	185.12±28.04
Control	163.46±28.77	163.46±28.77	163.46±28.77	163.46±28.77
P	0.003	0.002	0.001	0.001

*Hyperandrogenism and polycystic ovarian syndrome and oligomenorrhea; **Hyperandrogenism and oligomenorrhea; ***Hyperandrogenism and polycystic ovarian syndrome; ****Polycystic ovarian syndrome and oligomenorrhea. SD=Standard deviation; HDL=High-density lipoprotein; LDL=Low-density lipoprotein; Ch=Cholesterol; TG=Triglyceride

Table 2: The mean of fasting blood sugar and glucose tolerance test in different phenotypes of polycystic ovarian syndrome

Phenotype	Mean±SD			
	Type A*	Type B**	Type C***	Type D****
FBS				
Case	75.17±7.74	73.33±7.86	74.80±7.61	75.09±7.44
Control	76.91±6.56	76.91±6.56	76.91±6.56	76.91±6.56
P	0.20	0.04	0.159	0.22
GTT				
Case	89.5±27.4	88.47±25.3	89.03±20.98	89.02±15.98
Control	87.67±12.57	87.85±12.68	87.51±12.97	87.11±12.80
P	0.79	0.91	0.1	0.15

*Hyperandrogenism and polycystic ovarian syndrome and oligomenorrhea; **Hyperandrogenism and oligomenorrhea; ***Hyperandrogenism and polycystic ovarian syndrome; ****Polycystic ovarian syndrome and oligomenorrhea. SD=Standard deviation; GTT=Glucose tolerance test; FBS=Fasting blood sugar

glucose is not a sensitive method for diagnosis of diabetes in the patients suffering from PCOS.[21] In addition, incidence of diabetes in high-risk individuals requires long-term encounter with FBS and glucose intolerance. Considering the age of the individuals under the current study (14–18 years), hyperinsulinemia might not have affected the blood glucose changes greatly. In this regard, in a study in Austria, a group of women with normal weight underwent screening tests, such as glycated hemoglobin (HbA1c) and FBS. Based on OGTT, the incidence rate of diabetes was 12.8%. However, the results of HbA1c and fasting blood glucose indicated that, respectively, 3.2% and 5.2% of the patients were diagnosed with prediabetes. Thus, the researchers came to the conclusion that although OGTT is time-consuming, neither fasting blood glucose nor HbA1c could be used as appropriate screening tests for glucose tolerance disorder in PCOS.[22]

Hormonal fluctuations during transition to adolescence, which can lead to metabolic changes, may imitate MS characteristics. This has long attracted the researchers' attention.[23] In a study on 1098 adolescents, almost half of the participants were diagnosed with MS, but this diagnosis changed during the observation period 3 years later.[24] This might have resulted from lack of objective criteria for identification of MS in adolescents.

Overall, in our study, more metabolic abnormalities in Phenotypes B, C, and A were estimated, and minimal changes were seen in the Phenotype D. Our results are consistent with those of other studies.[25,26]

One of the limitations of the present study was restriction of doing physical examinations at schools. However, the majority of the students were convinced after the advantages of participation in the study were explained to them.

CONCLUSION

The results of the current study showed that the serum TG, cholesterol, and LDL levels were higher and HDL levels were lower in different phenotypes of PCOS. However, FBS and 2-h postprandial blood sugar were normal in both study groups. Given that PCOS is diagnosed in the ages around puberty, researchers must screen the syndrome and its risk factors.

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Conflicts of interest

There are no conflicts of interest.

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